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# THE GEOLOGY OF VAL VERDE COUNTY

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# A GEOLOGICAL RECONNAISSANCE OF VAL VERDE COUNTY.

By John R. Roberts

## INTRODUCTION

Val Verde County is bounded on the north by Sutton and Crockett counties, on the east by Kinney and Edwards counties, on the west by Terrell County, and on the south by the Rio Grande River. The total area of the county is approximately 35,000 square miles.

Del Rio, a small, thriving city of 6,000 inhabitants, is situated on the Galveston, Harrisburg, and San Antonio Railroad, the main line of the Southern Pacific Railroad, in the southeast corner of the county, and is the county seat. This city undoubtedly owes its original settlement to the San Felipe Springs, which are only one mile northeast of the town. The Galveston, Harrisburg and San Antonio Railroad enters the county at the east line, four miles east of the village of Johnstone, from whence it runs west and south to Del Rio, thence west and north, roughly parallel to the Rio Grande, and leaves the county at the west line, three and one-half miles northwest of Pumpville. West from Del Rio, situated on the railway, are successively, the villages of Devil's River, Feely, Comstock, Pecos High Bridge, Shumla, Langtry, Osman, and Pumpville. Some of these places are merely section houses, with a siding. Pandale, a post-office, is situated in Howard's Draw, four miles north of the Pecos River Crossing, and is 65 miles north and west of Comstock by wagon road. Juno, on the Devil's River, is 45 miles north of Comstock. The latter is a village 35 miles west of Del Rio, with a population of 300. The hamlet is composed of three stores, two hotels, a post-office, a telephone station, a railway station, and is the largest village in the county. The population of Val Verde County is 14,000 people, of whom one-half are Mexicans or people of Mexican descent.

Ranching, the raising of goats, sheep and cattle is the predominant industry of the county. The successful irrigation plant and farm of the Val Verde Irrigation Company, along the Rio Grande River and south of Del Rio, is also devoted to cattle-raising. Business enterprises of the city and villages are wholly dependent upon the grazing areas immediately contiguous for support. Time will show whether the manganese-bearing deposits now known at Shumla, at Feely, and between Langtry and Shumla, will have a share in the future productive wealth of Val Verde County. The presence of these deposits and the urgent demand for manganese are the primary causes of this hurried reconnaissance and short report of the geology of this, one of the larger counties of the State of Texas.

## PHYSIOGRAPHY

### DRAINAGE

The portion of Val Verde County west of the Pecos River is in the Trans-Pecos Physiographic Province of Texas. Two-thirds or more of the total area of the county, the part east of the Pecos River, is a part of the Edwards Plateau region.[1]

This river drains the Trans-Pecos Plains and a small area of the Plateau Region, and is the natural dividing line between the physiographic provinces.

The southern boundary of the county, the northern border of Mexico, is the Rio Grande River. This is the major drainage channel into which flow directly the Pecos River, the Devil's River, the Seymour Creek, the San Felipe Creek, and other smaller creeks of the county. Most of the latter are dry except during floods. All of the streams mentioned are fed to some extent by springs issuing from the Comanchean Limestone. In fact, San Felipe Creek is but an outlet for the waters of the springs of that name and lesser ones north of it.

### RELIEF

The Edwards Plateau is a great low plateau which is dissected by wide drainage channels leading out to its bordering scarps where they form canyons. From the top of the canyon walls, the entire horizon of the surrounding country appears to be almost level.

[1]R. T. Hill, Pt. 7, 21st Ann. Rep., U. S. G. S.
U. S. G. S. Topographic Atlas, Folio No 3.
Univ. of Tex. Bull., No. 44, page 17.

Near Shumla, and between the Rio Grande and Pecos rivers, the country is essentially a plateau which is cut by many arroyos and short canyons. The watershed between the two streams is a narrow undissected divide. Upon this divide the Southern Pacific Railroad is built. The canyon of the Pecos, whose walls are largely sheer vertical cliffs cut into the Comanchean limestone, is 320 feet deep at the High Bridge.

Four miles west of Shumla, the topography changes abruptly to that of high conical hills and rounded mesas, formed in the Eagle Ford formation, which are found south of the railroad to the Rio Grande, west beyond Langtry to Osman, north and west to the west line of the county, and north to within three miles of Chapote Well. Pumpville is situated on the northern edge of a well defined plateau that extends west into Terrell County, and south of the Rio Grande River. East of the hills there is a plateau sloping gently toward the Pecos, which is thoroughly and deeply dissected by the long canyons which trend in a southerly course to the river.

What is called the Ozona Road, leading north out of Comstock, is also known as the Divide Road. This road follows the crest of the watershed between the Pecos and the Devil's Rivers. It is probably nowhere more than 700 feet above the waters of either stream. Between this road and the Pecos River there are but two canyons of note: Howard's Draw, on the north, and Dead Man's Canyon, which enters the Pecos two and one-half miles north of the High Bridge. East of the road there are many small and a few large, deep gorges extending east and south to the Devil's River. The country between these boundaries is rough and badly cut up. All of the canyons have a sharp descent to the river; have steep, if not vertical, walls; are narrow, and are not far distant from one another.

The relief of the country south and east of the Devil's River is more mature than elsewhere in the county, and is characterized in the immediate vicinity of Del Rio by the more undulating outline of the hills, especially east and south of that city. Southeast of the town, the road to Eagle Pass is on an almost level plateau. Within the city limits, on the north, is found the southern border of a plateau that reaches west to the Devil's

River, north for fifteen miles, and east of the Del Rio-Canadian Highway two miles or less. The north half of that part of the county east of the Devil's River, is dissected by many large, wide, and comparatively deep canyons, whose general course is west and south to the river. This country has a similarity to that immediately west of the Pecos River, except that the canyons are longer, wider, and more advanced in their development in the cycle of erosion.

Though not mountainous, Val Verde County has a high, or, as we might say, deep relief in the many canyons that dissect it in reaching the rivers that drain the parts of the two physiographic provinces found within its boundaries.

## TABLE OF ELEVATIONS

The following elevations above sea-level of stations and sidings from Pumpville south and west across Val Verde County to Amanda, Kinney County, were furnished by Mr. C. R. Merrill, Assistant General Manager of the Southern Pacific Lines, at Houston, Texas.

| *Station or siding.* | *Elevation in feet.* |
|---|---|
| Pumpville | 1815 |
| Hijito | 1646 |
| Osman | 1570 |
| Bean | 1433 |
| Langtry | 1302 |
| Dorso | 1455 |
| Pecos Bridge | 1380 |
| Pecos River bottom, at R. R. bridge | 1060 |
| Rona | 1637 |
| Comstock | 1544 |
| Cabra | 1410 |
| Feely | 1238 |
| Bullis | 1136 |
| Devil's River bottom, at R. R. bridge | 728 |
| Devil's River Station | 953 |
| McKee | 924 |
| Del Rio | 959 |
| Johnstone | 1086 |
| Amanda | 1087 |

## SOILS AND VEGETATION

The principal agricultural soils of Val Verde County are the alluvial deposits of Pleistocene Age found in the canyons leading to the Pecos and Rio Grande Rivers, and south of Del Rio along the north bank of the latter stream. The Val Verde Irrigation Company is successfully using the water of the San Felipe Springs in irrigating the several hundred acres of alluvial soil it has under cultivation. Here and there in the canyons are small patches of alluvium, a few acres in extent, that are irrigated and farmed. The residual soils of the Comanchean limestone are thin and of no agricultural worth, for throughout the county this formation is practically naked and barren. The same remark does not apply as fully to the residual soils of the Eagle Ford formation. In the south-west corner of the county, in the vicinity of Pumpville, the plateau is in part covered by a reddish-brown residual soil derived from the Eagle Ford formation. This soil has an average depth of eighteen inches, and if it could be irrigated cheaply, would no doubt be productive. Elsewhere throughout the county there is but little soil left as a residual product of the weathering down of the Eagle Ford..

The vegetation growing upon the two formations is somewhat distinctive of them, and on both, it is typical of a semi-arid climate. The Comanchean limestone supports scrub-cedar, scrub-oak, mesquite, cacti, sotol, lechugilla, and chaparral in relative abundance. Along the bottoms of the Devil's River are oak and cypress trees. The grasses immediately adjacent to the stream grow abundantly in the river silt and debris. The Eagle Ford vegetation consists of chaparral, scrub mesquite trees, spanish bayonets, cacti of many varieties, lechugilla, sotol, and occasionally a knotty, twisted scrub-oak; but no cedar tree was ever observed on this formation.

In February and March of this year (1918), nearly all grass was killed by a long-continued drouth. This drouth, extending back for a period of two years, had almost stopped the growth of all plants. Sheep and goat-raising has been and is now being successfully carried on in this county. Heretofore, cattle raising has been successful, but since fencing of pastures has been introduced, this form of ranching is said to be on the decline.

## GEOLOGY

### THE COMANCHEAN

The alluvial deposits south of Del Rio and elsewhere along the Rio Grande River are of Pleistocene age. The Cretaceous sediments constitute the bed rock in Val Verde County. The Cretaceous is divided into the Upper Cretaceous, and the Lower or Comanchean Cretaceous. In this county the Comanchean is represented by the Devil's River limestone, including the Edwards formation of the Fredericksburg division, the Georgetown formation, the Del Rio clay, and the Buda limestone, all of the Washita division. The Upper Cretaceous is represented only by the Eagle Ford formation. The contact of the Upper Cretaceous and Comanchean is the dividing plane between the Buda and Eagle Ford formations. These are sediments of quite different lithologic character and texture.

#### *The Devil's River Limestone*

The Devil's River limestone was not differentiated into its component parts, the Edwards and Georgetown formations, for the purpose of this survey, because of the close lithologic similarity of the two, and because of lack of time for detailed study.

For the original definition of this formation as here used the reader is referred to a paper by Udden published in 1907.*

The Devil's River formation varies within certain limits in color, structure, and composition. In the gorge of the Pecos River, in the bend north of Shumla, the uppermost beds of this formation are exposed, and they are conformably capped by the Buda, which is included in the following vertical section taken from the west wall and numbered from the bottom up.

*Report on a Geological Survey of the land belonging to the New York and Texas Land Company, Ltd., in the Upper Rio Grande Embayment in Texas, pp. 56-60, Augustana Libr. Pub. No. 6.

| | | Thickness in feet. |
|---|---|---|
| 11. | A heavy-bedded, hard, dense, white limestone, containing a few flints at the base and fossil shells which are filled with calcite and are poorly preserved. This rock is remarkable in that it appears to be an almost pure calcium carbonate | 60 |
| 10. | A thin-bedded arenaceous limestone, alternating with two-inch seams of calcareous, brown clay | 7 |
| 9. | Hard, compact, gray limestone having many fossil shells very poorly preserved | 3 |
| 8. | A stratum of compact white limestone containing flints, and which is also cut diagonally from top to bottom with open fractures a few inches wide, and from 6 to 10 feet apart. The fissures are filled with honey-combed limestone fragments | 18 |
| 7. | A one-foot shelf of dense blue limestone projecting a few inches beyond the face of the bed below. This rock weathers smooth, though composed of small, blue-tinted calcite crystals surrounded by a hard, blue-black, limy matrix | 1 |
| 6. | A stratum of heavy-bedded, hard, yellow-white limestone, which has a sub-conchoidal fracture, and has specks of brown iron oxide and indistinct lines of stratification. The base is made up of an 8-inch stratum of a compactly consolidated conglomerate composed of flint nodules and a marly calcareous matrix, which imperceptibly merges into the bed above | 19 |
| 5. | A thick stratum of honey-combed, jointed, and weathered limestone that is easily distinguished by the caves within it. On a fresh surface, it is dark bluish-gray, and has well developed crystals of calcite. Some of the caverns extend into the wall for 6 or 8 feet and have their roofs 10 or 12 feet above their floors. Within the caverns on the walls, can be seen fine laminations in the limestone that cannot be observed on a fresh fracture. Flint nodules 6 to 8 inches in their longer dimensions are abundant in this bed | 50 |
| 4. | This stratum is like the lower 30 feet of number 5, without the large cavities of the latter, and with flint nodules in place in the exposed face | 30 |
| 3. | A zone of fractured or crushed rock | 3 |
| 2. | This bed is a limestone, on weathered surface of bluish-gray color, showing innumerable small cavities 1 to 1½ inches in surface extent, and penetrating the face from a quarter of an inch to 3 inches; honey-combed only at the surface. On a fresh fracture, the rock is seen to be a fine-grained, compact limestone, with a greenish tint, containing minute | |

| | Thickness in feet |
|---|---|
| crystals of calcite and fossil imprints which are indistinct parts of large shells | 25 |
| 1. A waterworn and weathered limestone, stained and coated with reddish-brown silt. Fresh surface shows small crystals of calcite imbedded in a matrix of bluish light gray, calcareous material, having many minute stains of brown iron oxide | 3 |
| | 220 |

This represents only a small part of the formation, which measures some 500 feet on Devil's River.*

All of the strata described lie practically horizontal.

In color, composition and texture, the Comanchean limestone changes from a coarse-grained, crystalline, blue-gray rock containing layers and cakes of flint in some places, to a rock that is soft, yellow, friable, jointed and honey-combed. The latter beds are excellent channels for underground waters. Another distinctive feature is the number of caves that are found along the canyon walls of the Rio Grande, the Pecos, and the Devil's Rivers. All of the canyons and gorges of the county are etched out of this limestone.

The Comanchean has the greatest areal distribution of the geological formations found in Val Verde County. It has its narrowest exposures on the west bank of the Pecos River and at different places along the Rio Grande, where the Upper Cretaceous extends almost to the canyons at some points.

### *The Del Rio Clay*

The Del Rio clay is mostly a laminated greenish blue clay, with thin layers of impure clayey, sandy material, and limestone flags. The most prominent characteristic of this clay is the presence of large numbers of the fossils *Exogyra arietina*, or "ram's horns," which are present in all its horizons, and in some layers form thin slabs of shell breccia. Wherever the Del Rio formation was observed in this county, the fossil *Nodosaria texana* was invariably present, as were also crystals

*Loc. cit.

of gypsum and pyrite. In lithologic character this formation varies from a clay to an arenaceous, thin-bedded limestone. On Section 615 of the Consolidated El Paso Irrigation and Manufacturing Company survey, about four or five miles southwest of Shumla, there is an outcrop ten to fifteen acres in extent. Here the formation consists of alternating three and four-inch limestone layers and thin strata of slightly different character, impregnated with black oxides of manganese and the red and brown oxides of iron. This remnantal outlier has a vertical thickness of approximately 15 feet, and represents probably only the uppermost strata of the formation. The contact with the underlying formation is hidden by surface debris, but the correlation of the outlier as Del Rio is made certain by the presence of both *Exogyra arietina* and *Nodosaria texana.*

In areal distribution the Del Rio clay is found in small outliers west of the Pecos River, adjacent to Shumla. Outcrops are found at Comstock in all directions within a short distance of the village, and southeast along the Del Rio road to within a half mile of the Devil's River. North of the city of Del Rio, the formation is nowhere over fifty feet thick, and varies from that to nothing. South of town there is a rounded hill that shows very clearly the effect of erosion upon the Del Rio clay. East and south of Del Rio the clay has its greatest thickness of barely 200 feet. In many places this member of the Comanchean is absent, as at the Pecos River ford on the Pandale road, in the canyons of the Rio Grande south of Langtry, and in most of the Shumla district.

## *The Buda Limestone*

The Buda limestone is of especial interest for along its joints and cavern faults, are found small bodies of manganese-bearing material. It will be described in detail in connection with these. This formation changes somewhat in its character, though its compact texture, its sub-conchoidal fracture, and its lack of fossils are distinctive in Val Verde county. A white, almost pure calcium carbonate forms its upper beds, without clear lines of stratification. The thin bedding at the middle of the formation, and some blue beds, are also salient features of the Buda here, which are not always to be noted elsewhere.

By far the greater areal distribution of this formation is in the southeast part of the county and bordering the Eagle Ford beds.

Following are two detailed sections of the Buda formation. On Section 704 of the Consolidated Irrigation and Manufacturing Company Survey, two and a half miles southeast of Shumla, in a cut on the abandoned line of the Southern Pacific Railroad, the Buda limestone is exposed. A section was taken at this point of the exposure and is as follows, beginning at the base:

| | Thickness in feet | —inches. |
|---|---|---|
| 1. Hard blue limestone, which is badly shattered, jointed, and cracked. A few Pectens noted................ | 8 | 0 |
| 2. A seam of sandy, calcareous, yellow clay.............. | 0 | 8 |
| 3. A bed of hard, yellowish-white, limestone, in which there is not a trace of bedding. This rock has a sub-conchoidal fracture, and might be easily mistaken for a chert from its color and mode of fracture, on a weathered surface........................ | 40 | 0 |
| | 48 | 8 |

About three miles west of Shumla in a cut of the Southern Pacific Railroad, on Section 57 of the East Line and Red River Railroad Company's Survey, the following section was taken, from the bottom up:

| | Thickness in feet | —inches. |
|---|---|---|
| 1. A hard, flint-like limestone, shattered and broken... | 2 | 0 |
| 2. Four-inch seam of thin-bedded limestone and yellow clay ........................................ | 0 | 4 |
| 3. A shattered and broken, hard, yellowish-white limestone ........................................ | 1 | 2 |
| 4. A seam of yellow sandy clay...................... | 0 | 2 |
| 5. A seam of hard, white limestone.................... | 1 | 3 |
| 6. Thin-bedded limestone, intercalated with yellow clay | 0 | 5 |
| 7. Massive limestone, jointed and cracked into angular blocks ........................................ | 4 | 0 |
| 8. A seam of yellow clay.......... ................. | 0 | 2 |

| | | Thickness in feet | inches |
|---|---|---|---|
| 9. | Badly shattered white limestone | 4 | 0 |
| 10. | Pinkish white clay | 0 | 3 |
| 11. | A layer of hard, almost pure white, chert-like limestone | 1 | 4 |
| 12. | Surface material of shattered limestone, dark brown shale having fish scale fragments, and residual soil. This is a remnant of the Eagle Ford formation, which otherwise has been almost entirely eroded away | 2 | 0 |
| | | 19 | 9 |

UPPER CRETACEOUS

### *The Eagle Ford Formation*

As has been stated, the Eagle Ford shale or Boquillas Flags is the only representative of the Upper Cretaceous found in Val Verde County. The two names under which it is known suggest that this formation varies in lithologic character, and so it does. In Central and North Texas the formation consists of clays and sandstones. "In the Quitman Mountains, this formation consists of dark brown shales and bands of impure sandstones. In the Big Bend country this formation consists of limestone in flaggy beds, which contain a slight admixture of fine siliceous sand and clay. At certain horizons they have a chalky texture. The color varies between gray, yellowish-white, and dark to almost black. These rocks were named Boquillas flags by Udden."[1] Further detailed study has revealed other lithologic differences in this formation. Some of these changes are shown in the following notes which were taken at different points west of the Pecos River, where the Eagle Ford has its greatest thickness within the county. About five miles west of Langtry, on Section 125, Block S-3, of the East Line and Red River Railroad Company's Survey, on Rattlesnake Creek, there is a series of exposures of eight to eighteen inch beds of hard, ringing limestone flags intercalated with eight to twelve inch beds of blue, faintly bituminous shale. The shales have

[1]Univ. of Tex. Bulletin No. 44, pp. 77-78. For the original detailed description of the Boquillas flags see Geology of the Chisos Mountains, pp. 29-33, Bull. U. of T. No. 93.

fragments of included fish scales, and the flags have casts of Inocerami.

In Pump Canyon on Lot 19, Block A-1, of the Galveston, Houston and Harrisburg Railway Company's Survey, one mile southwest of Osman, a section was taken from the bottom up, as follows:

| | | Thickness in feet | inches |
|---|---|---|---|
| 16. | A layer of hard, bluish-white limestone, which is deeply weathered | 1 | |
| 15. | Calcareous, thin-bedded grayish shale. Laminations quite distinct | 3 | |
| 14. | An eight-inch layer of hard compact limestone. Oxide of iron present | | 8 |
| 13. | A bed of thin sandy shales intercalated with clay and impure bentonite | 3 | 6 |
| 12. | A layer of hard bluish-gray dolomitic limestone | | 6 |
| 11. | A bed of sandy shale with seams of clay containing the brown and red oxides of iron | 4 | |
| 10. | A bed of hard, gray, compact limestone, with brownish stains | 1 | |
| 9. | A sandy, calcareous light brown shale, alternating with seams of sandy clay | 2 | 6 |
| 8. | A bed of hard, blue-gray limestone, containing casts of Inocerami and brown specks of iron oxide | | 10 |
| 7. | Calcareous shale, thin-bedded, weathers to a light brown. Laminations noted on weathered surface that are not seen on a fresh one | 3 | |
| 6. | Thin-bedded limestone flags, grayish-white on a fresh surface, and showing spots of brown iron oxide | 1 | |
| 5. | A sandy, calcareous shale which is very thin-bedded. On a fresh surface fine grains of white sand are seen in a light gray matrix. These strata weather to a light brown color | 5 | |
| 4. | Thin beds of hard limestone flags from eight to ten inches thick, with iron oxide in the planes of the partings | 10 | |
| 3. | Heavy-bedded, blue, bituminous shale, with many fragments of fish scales | 4 | |
| 2. | A thin bed of hard bluish-gray, ringing limestone, showing specks of iron oxide | | 8 |
| 1. | A heavy bed of bituminous shale, which is dark blue and finely laminated on a fresh surface. This shale burns readily in a wood fire | 8 | |

Many fish scales and a few casts of fish were noted in the bituminous shales and casts of Inocerami in the flaggy strata. Interstratified in the beds of light-colored, non-bituminous shales were found some thin layers one to two inches in thickness, of impure bentonite, which is here heavily impregnated with the red and brown oxides of iron.

On Section 97, Block D, of the East Line and Red River Railroad Company's Survey, three miles northwest of Langtry, there is a scarp striking N. 15° E., upon which there is a layer about 20 feet thick of caliche, lying in crenulated folds. The Buda is seen as the basal 20 feet of this outcrop. To the southwest, along the strike, the contact between the Eagle Ford formation and the Buda limestone can be observed.

Near a fence on Section 75, Block S-2, of the East Line and Red River Railroad Company's Survey, about five miles northeast of Langtry, on the southern slope of the hills of the Eagle Ford formation, were gathered specimens of float iron and manganese ores, which can be found in large numbers. Between Langtry and this point, as one drives along through and over the Eagle Ford hills, can be observed in the canyons of the dry creeks the sharp contact between the Eagle Ford and Buda formations. Some of these Eagle Ford hills have an altitude of two hundred and fifty to three hundred feet, and from a distance these appear to be somewhat cone-shaped. The mesa-like levels of the hilltops are practically horizontal.

On Section 83, Block S-2, of the East Line and Red River Railroad Company's Survey, in a cut of the Southern Pacific Railroad, four miles east of Langtry, there is exposed the contact of the Buda and Eagle Ford formations. This contact is shown to be clearly disconformable upon a former erosional surface of the limestone. This is not an angular unconformity and might easily be mistaken for a conformity, if one did not observe closely the minute disconformities caused, as is believed, by underwater erosion of the Buda by currents in the Upper Cretaceous sea. The chalky-white and angularly jointed Buda is overlain by the dark brown, thin-bedded strata of the Eagle Ford shales, which contain many fragments of fish scales and a few casts of Inocerami. Wherever observed by the writer, the contact of the Upper Cretaceous and the Comanchean, that is, the Buda and Eagle Ford formations, in Val Verde County, was found to be disconformable on a former erosional surface, and marked by one or more of the distinctive characteristics mentioned above. See Plate 2 *a*.

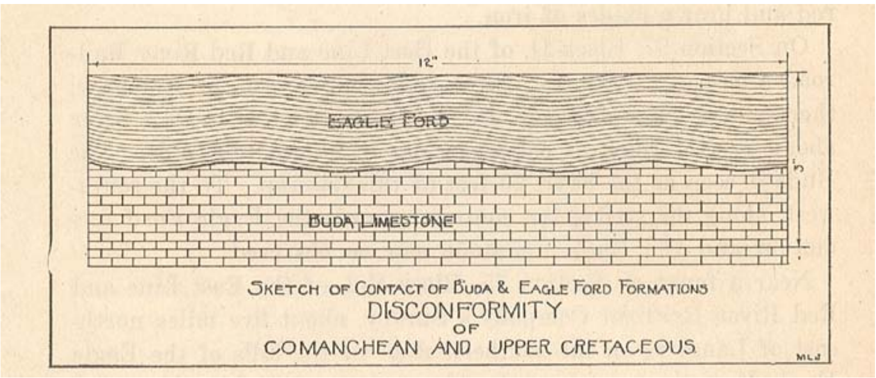


Figure 1. A sketch showing the disconformity between the Buda limestone and the Eagle Ford shale.

In areal distribution the Eagle Ford formation has its greatest extent west of the Pecos River, and between that stream and the Devil's River. There is also a tongue of this formation, not over eighty-five feet in thickness, projecting into the southeast corner of the county with outliers to the north and east. On its northern boundaries, the Eagle Ford is thin, so thin in fact, that for miles it is not over 4 feet thick, except in isolated remnants. Within five miles north, east, and west of Langtry, in the hills, the Eagle Ford has its greatest observed thickness of three hundred feet.

On the surface of the Eagle Ford are found, widely scattered about, small areas of red ferruginous chert.[1] The surface of this formation, wherever noted, is strewn with oblong limestone flags. These blocks rarely are over 8 inches thick and 10 inches wide, but are usually three times, or more, longer than either of the other two dimensions. A marked feature of them is a tendency of the surface to become deeply pitted with small

[1]Citizens of the county have at times gone to the expense of having this material analyzed for gold. This is useless.

rounded holes and to have depressions an inch across and one-quarter of an inch or less in depth. When well weathered, the rounded, acute angled corners of the flags project prominently, as they do not wear away as fast as the body of the rock; due probably to the concentration by solution at the edges of the block, of the iron oxides, which were contained originally as the iron sulphide, pyrite, in the limestone at the time of deposition.

## THE PLEISTOCENE

The Pleistocene deposits consist of thin gravels, soil and caliche on the uplands and alluvial silts with sand and gravel in the valleys. These must be passed without further notice, to await more detailed attention by geologists at some future day.

## GEOLOGICAL STRUCTURE

The elevations of the stations and sidings of the Southern Pacific Railroad from Pumpville to Johnstone show a general southeastern slope of the surface of the land, toward the Gulf of Mexico. The railroad is roughly parallel to the Rio Grande and crosses both the Pecos and Devil's Rivers. Study of the railroad profiles combined with field observations of the slopes of the Comanchean surface point to the existence of a wide syncline trending from northwest to southeast through the county. The long southwest limb extends for some miles west of Watkins, in Terrell County, east to the Pecos River. The northeast limb is far shorter and extends but a few miles east from the Pecos to the crest of the Pecos-Devil's River watershed. From Comstock east, the Comanchean surface descends to the Devil's River from where it again rises to Johnstone and beyond. This indicates that the Pecos and the Devil's Rivers are both situated in synclines and that they are consequent streams.

In the accompanying table are given the approximate elevations of the surface of the Comanchean formation at some points on the Southern Pacific Railroad in Terrell and Val Verde counties.

| Location. | Elevation in feet. |
|---|---|
| Five miles west of Watkins, Terrell County | 1853 |
| Watkins, Terrell County | 1770 |
| Malvado, Terrell County | 1570 |
| Lozier, Terrell County | 1560 |
| Bean, Val Verde County | 1433 |
| Langtry, Val Verde County | 1300 |
| Shumla, Val Verde County | 1412 |
| Pecos Bridge, Val Verde County | 1380 |
| Two and three-quarters miles west of Comstock, Val Verde County | 1559 |
| Comstock, Val Verde County | 1600 |
| Feely, Val Verde County | 1240 |
| Devil's River, Val Verde County | 1015 |
| Johnstone, Val Verde County | 1186 |

Two structures within the indicated Devil's River syncline in Val Verde County have been noted and described by Udden as follows: "We find a rather abrupt reversal of the general southward dip in the Devil's River region about one mile north of the bridge of the Southern Pacific Railroad. At this place there is a small anticlinal fold with its axis extending from east to west for several miles. To the north of this axis the ledges of the Devil's River limestone dip northward for a few hundred yards, descending as much as fifty feet, before again resuming their slow climb in that direction. Another fold of about the same size and direction was noted two miles north of Del Rio. This latter fold extends several miles to the east of Del Rio, so that the dip at several points east of Del Rio is to the north even as far out as near the railroad bridge over Sycamore creek."[1]

More detailed field study than the present writer was able to make in the limited time at his disposal may reveal other like structures in the county.

[1]Report on a Geological Survey of the Lands belonging to the New York and Texas Land Company, Ltd., in the Upper Rio Grande Embayment in Texas; Augustana College Library Publications, No. 6, pp. 87, 88.

### VULCANISM

Intermittent volcanic activity took place at some distant point concomitantly with sedimentation during Eagle Ford time. This is shown and proved by the presence of the mineral bentonite, a volcanic tuff, intercalated within the strata of the Eagle Ford formation. So far as observed in this county, the bentonite is so impure and in such thin layers as to have no economic value in the industrial arts, as a fuller's earth.

## ECONOMIC NOTES

### THE MANGANESE-BEARING DEPOSITS NEAR SHUMLA

#### *Introductory*

There are some manganese-bearing deposits at Shumla and Feely. These are now of special interest, since manganese imports have almost ceased. These deposits were known some years years ago, but until recently no enterprising citizens have sought to make use of them. Heretofore, the principal users of manganese in this country have to a large extent been relying on the high grade manganese ores from Brazil, Russia, and India. These sources of supply have been curtailed, owing to war conditions in Russia and to scarcity of ships in which to transport the Indian and Brazilian ores. With an increasing demand and a decreasing supply, munition manufacturers, steel makers, tool-makers, and allied branches of industry have been forced to use domestic ores. The American ores are of lower grade and of a somewhat different nature from the imported ores. The use of the latter has involved a change in metallurgical practice, which will perhaps become permanent, and may create a continuous demand for such manganese ores as are found in Texas, if they shall prove sufficiently rich.

Mineralogists have studied and identified in nature, no less than one hundred and eleven manganese-bearing minerals.[1] So far as known at present, there have been found in Val Verde County but three of these minerals. They are pyrolusite, wad,

[1]E. C. Harder, U. S. Geol. Surv. Bull. 427, pp. 20-23.

and bog manganese. It is quite probable that the protocarbonate of manganese, rhodocrosite, is also present. The mineralogic characteristics of pyrolusite, wad, and bog manganese, as given in Dana's Mineralogy, are as follows:

"Pyrolusite: $MnO_2$. Orthorhombic in crystal form. Commonly columnar, often divergent; also granular, massive and frequently in uniform coats.

Soft, often soiling the fingers. Hardness from 2 to 2.5. Specific gravity from 4.73 to 4.86. Metallic lustre. Color, iron-black, dark steel-gray, sometimes bluish. Streak, black or bluish-black, sometimes submetallic. Opaque.

Chemical composition: Manganese dioxide. Commonly contains a little water (2 per cent).

Mineralogists are uncertain whether pyrolusite is an independent species with a crystalline form of its own, or only a secondary mineral derived chiefly from the dehydration of manganite, and possibly polianite."

"Wad: An impure mixture of manganese oxides. Occurs in amorphous and reniform masses, either earthy or compact; also as incrustations or stains. Usually very soft; soiling the fingers; less often hard, rarely has a hardness of 6. Specific gravity from 3.0 to 4.26; often loosely aggregated, and feeling very light to the hand. Color, dull black, bluish or brownish black."

"Bog manganese consists mainly of oxides of manganese and water, with some oxide of iron, and often silica, alumina, and baryta.'

In this county, wad and pyrolusite are the only ores of manganese that have any prospective commercial importance to date. No attempt has been made to markedly differentiate the two minerals either in the field or laboratory. They are so intimately intermixed that such an effort would have little or no scientific or commercial value, that cannot be better shown by the chemical analyses that are given elsewhere.

### *General Character of the Manganese-bearing Deposits*

Manganese-bearing material outcrops at the surface at many places in the area immediately adjacent to the west of Shumla, and southwest of this station, in the bend of the Rio Grande River, also, south of the Southern Pacific Railroad in the point of land formed by the junction of the Rio Grande and Pecos Rivers. Five miles north of Shumla, on Section 42 of Block

S-2, of the East Line and Red River Railway Company's Survey, is an outcrop of manganese ore material that is more easily reached from Langtry by automobile than any other point on the railroad. All of the exploration developments have here been started on surface exposures of ore material in so called "breaks."

The word "break" is adopted in this paper from the language of the local prospectors. It designates the clefts in which the ore occurs, and is not to be confused with the topographic use of the same term. The manganese-bearing materials do not occur in veins, but are rather cavern and sink deposits. It is believed by the writer that these breaks are not the direct result of faulting, but rather that they have developed by solution along dip and strike joints. The breaks are roughly at right angles to the axis of the Pecos River syncline. Their direction may be a result of the forces which have produced that structure. In general, the breaks are approximately parallel to each other and from one to two miles apart. Further systematic explorations will no doubt bring to light more mineralized breaks than are at present known. Those examined by the writer are shown on figure 2. The mineralized breaks have been seen to extend through vertical depths of three hundred feet on some of the canyon walls in the region, but it is thought that these occurrences are quite exceptional and represent points where the depositing waters have descended to unusual depths in their otherwise mostly horizontal courses. The depth of the deposits is probably much less, in most instances. They have not been successfully traced across all the numerous arroyos that lead to the Rio Grande and Pecos Rivers. The major breaks whose trend is, as a rule, N. 40° E., must be covered in the bottoms of the arroyos by surface débris, if they exist there.

The longer breaks are two miles or more in length and are from a few inches to three hundred feet wide at different places along their course. The larger ones, trending approximately northeast and southeast, have laterals running more directly north and east, from them. The junction of the laterals and main breaks seems to have been favorable to the accumulation of manganese ore material.

Float manganese is found quite abundantly at many places along the breaks. No big pieces of float have been found. None of it observed by the author is over three inches in greatest dimension. The breaks are all easily traced on the surface by float, by the greenish color of the residual soil in the slight depressions between the limestone walls, and by the heavier growth of chaparral along their course.

West of Feely, a mile or so, on Section 44 of the International and Great Northern Railroad Company's Survey, and on Lot 52 of the Galveston, Harrisburg and San Antonio Railroad Company's Survey, is a break perhaps slightly faulted, trending N. 40° E. A total of six prospect pits has been put down on the outcrops of manganese ore material along the course of this break, within a distance of a half mile. Figure 3 shows their location. Not enough systematic prospecting had been done in this vicinity at the time of the writer's visit for him to state that this break is the only one. It is thought that others, either laterals or major breaks, will be found without much difficulty, by careful field work.

The locations given on figures 2 and 3 are approximate, and are shown as located for the writer by the explorers, when he was with them in the field. He has not had the time to accurately survey the ground to make precise locations, nor does the economic value of the manganese ore material shown up at present warrant such an expense.

### *Geological Formations in which the Manganese is Found*

Manganese occurs in all of the geological formations known in Val Verde County. Southeast of Shumla, manganese is found in an outlier of Del Rio clay at a point indicated as 8, figure 2. Southwest of Shumla, manganese is found in the upper horizons of the Edwards limestone, in a tunnel on Section 62 of Block S-2, of the East Line and Red River Railroad Company's Survey, and on Section 42 of the same Block. Most of the better manganese ore material deposits are in the

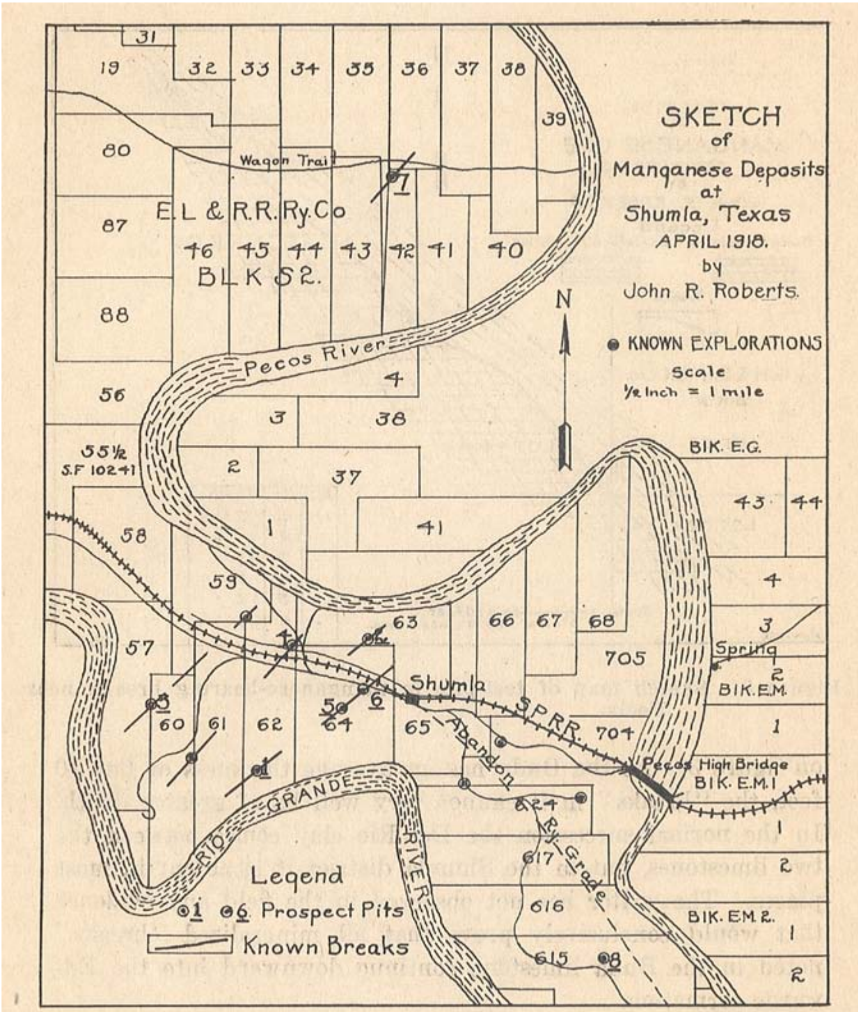


Figure 2. Sketch map of Shumla and vicinity, showing land surveys and approximate locations of prospect pits in manganese-bearing breaks.

Buda limestone. West of Feely, manganese ore material occurs on Section 52 of Block N, of the Galveston, Harrisburg and San Antonio Railroad Company's Survey, and on Section 44 of the International and Great Northern Railroad Company's Survey, in both the Buda and Eagle Ford formations, and also at the contact of the two formations in the break fault shown

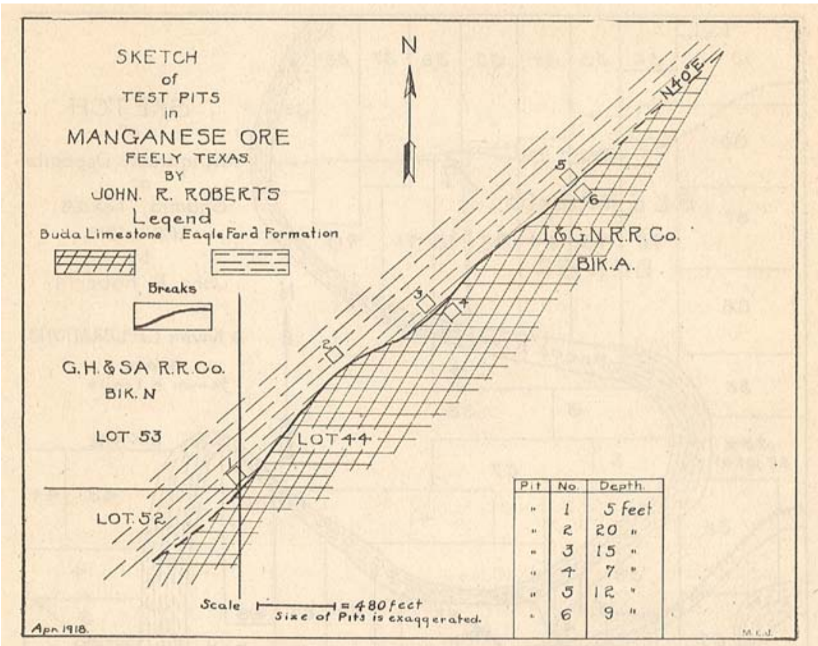


Figure 3. Sketch map of test-pits in manganese-bearing breaks near Feely.

on figure 3. As the Buda has an average thickness of but 70 feet, the "breaks" in it cannot very well be of greater depth. In the normal succession the Del Rio clay comes between the two limestones, but in the Shumla district it is absent in most places. The writer has not observed in the field any evidence that would conclusively prove that all mineralized "breaks" noted in the Buda limestone continue downward into the Edwards formation.

### *Detailed Descriptions of Explorations*

Beginning at Shumla, with the prospect explorations of Scherer & Whall, who have been the first active seekers for manganese ore bodies, the tunnels, trenches, glory-holes, pits, and outcrops visited will here be described in detail and in some instances illustrated by field sketches.

On the southwest side of Section 62 of the East Line and Red River Railroad Company's Survey (see figure 2), at the point marked "1," are a tunnel and a pit in manganese ore-bearing material, in a "break" trending N. 40° E. in the Edwards limestone. The entrance of the tunnel is 6'x6' and is approximately 10 feet above the bottom of a dry arroyo that trends south and east. At this point the bottom of the arroyo is about one hundred feet lower than the plateau which it cuts. The pit is 10 feet east of the tunnel entrance and is cut as a semi-circle into the slope of the arroyo wall. Its diameter is 6 feet and depth 10 feet. The accompanying sketches of the east wall and breast of the tunnel and pit show the relationship, in situ, of ore, ore-material, clay boulders and country rock.

The ore is a mixture of wad and pyrolusite, clay and lime; and is very porous. It appears to be a filling in the limestone in an underground water channel. It has no well defined relation to the present erosion surface. The clay has various colors and textures, ranging from bluish-black coarse lumps through a compact, dark yellow, wax-like earth, to an almost pure white kaolin of fine texture. There are seams or stringers of ore in the clays leading from the larger lenses. In the ore material are

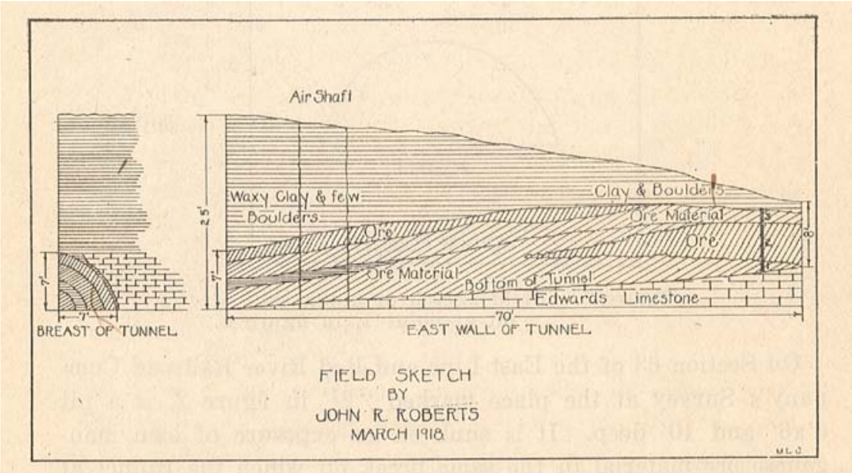


Figure 4. Field sketch of east wall and breast of tunnel at point 1, in figure 2.

thin bands of yellow clay or lime and vegetable matter. The boulders are masses of limestone differing in size from a few inches to a foot or more in diameter. As will be observed from the sketches, the ore material occurs in lenses and these are not altogether homogeneous mixtures of ore material, clay, and limestone boulders, but have the richer ore materials on top.

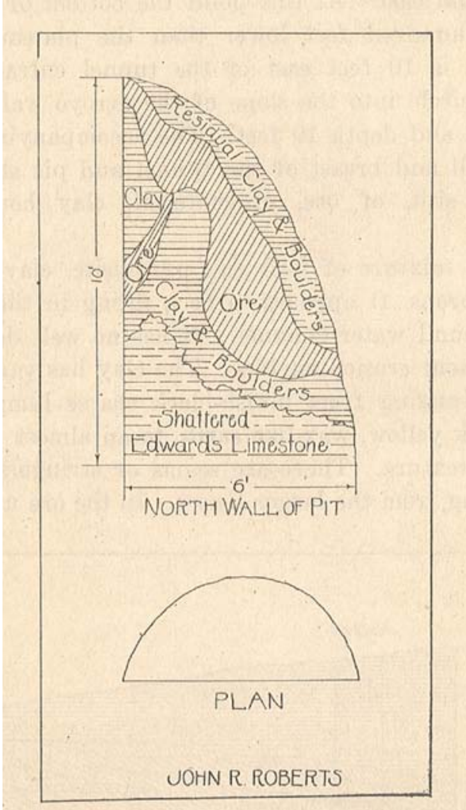


Figure 5. Field sketch of north wall of pit at point 1, in figure 2.

On Section 63 of the East Line and Red River Railroad Company's Survey at the place marked "2" in figure 2, is a pit 6′x6′ and 10′ deep. It is sunk on an exposure of lean manganese ore material in the same break on which the tunnel at point "I" is located. A slightly different character of material is shown in this pit than is found in the tunnel two and a quarter miles southwest. The ore material occurs in a distinct lense 18 inches thick, dipping to the southeast at an angle of 75° and is a pyrolusite, wad, and limestone nodule conglomerate, which is loosely cemented. The interstitial spaces contain much fine, light gray, sandy clay. The porosity of this ore material is great. There are many small seams of ore material less than one-half an inch thick, running parallel to the larger lenses, in the compact, yellow, wax-like clay that lies above and beneath it. In the clay below the ore material are some rotten limestone boulders eight to ten inches in diameter, resting on top of the country rock, which is the Devil's River limestone. The limestone lies horizontal, is of a dirty yellow color, and is jointed, cracked, porous, and partially disintegrated. This rock here resembles the Buda limestone. Close inspection of a fresh surface reveals the presence of poorly preserved calcite crystals, which have a greenish-blue tint. It is probable that most of the Buda has been eroded away at this point and the present surface is at the former contact of the two formations, the Buda and the Devil's River limestone.

On the line of Sections 57 and 60, of the East Line and Red River Railroad Company's Survey, figure 2, at the point marked "3" is a surface exposure not over forty acres in extent, on a low hill, of a horizontal, banded, indurated, sandy limestone of dirty red color. In places it is thin-bedded and intercalated with seams of iron and manganese oxides. This is evidently a remnant of the Eagle Ford. The surface is strewn with fragments of this formation. Due to its dominant red color this outcrop can be seen plainly from a distance. A few fragments of fish scales were noted in the shaly limestones.

A break trends northeast and southwest across this outcrop. It is not wide, not over two feet, though its strike can be traced by the difference in color of the residual soil within it. Nothing but two or three thin layers of limestone impregnated with black oxides of manganese have been found in the shallow pits dug. This outcrop is believed to be a remnantal outlier of the Eagle Ford formation. The vertical succession is not greater than ten feet, though the contact with the underlying formation was not seen, as it is hidden by surface debris.

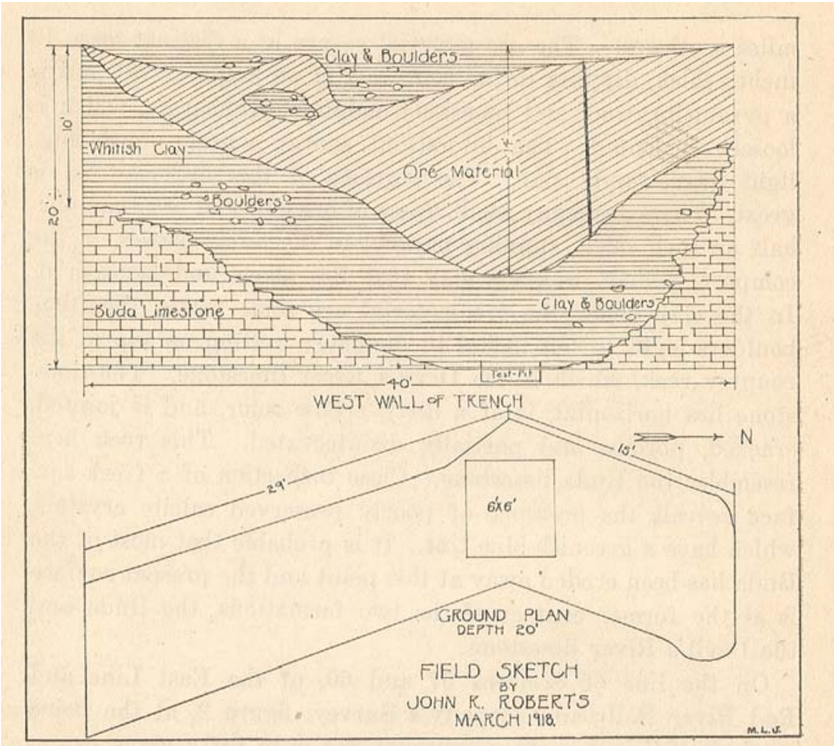


Figure 6. Field sketch of trench at point 2, figure 2.

On Section 62 of the East Line and Red River Railroad Company's Survey, north of the Southern Pacific Railroad line at the point 4, figure 2, is a trench situated on a widening in the same break. Here it is in the Buda limestone, like the shallow pits at point 2. It cuts the ore material diagonally. The trench is an oblique triangle whose apex is to the north. The southwest leg is 20 feet long. The length of the southeast leg is but 8 feet. The average depth of the trench is 8 feet and the average width is 3 feet. Below is a sketch of the south walls of the two legs, which shows the relationship of ore material, clay, boulders, and country rock.

The ore material is wad and pyrolusite, rich in lime and intimately mixed with clay. It is distinctly low-grade, very porous and soft enough to soil the fingers readily. Secondary concentration by leaching and redeposition is noticeable in the lower portion of the ore lenses. The ore material does not appear to have a well defined relation to the present erosion surface. The boulders are hard, massive limestones of a dirty yellow color, that range up to two feet in diameter. The clay is dirty brown and has a wax-like consistency when fresh. At the bottom of the trench the limestone is broken, porous, and partly disintegrated. Upon a fresh surface it is of a yellow cream color, and has a sub-conchoidal fracture, with no sign of bedding or lamination. No fossils were noted in this rock.

On Section 64 of Block S-2, of the East Line and Red River Railroad Company's Survey, at the point marked "5," figure 2, is a trench as shown below in the sketches. The relationship, in situ, of the ore material, clay, boulders, and limestone, is shown as they appeared at the time of the writer's inspection.

Usage of the designation "ore materials" is justified by the fact that it is a mixture of wad, carbonaceous vegetable matter, and thin irregular bands and bunches of clay. It is exceedingly porous and in color varies from a brown to a bluish-black. The clay is compact, yellow, and wax-like, and is practically free

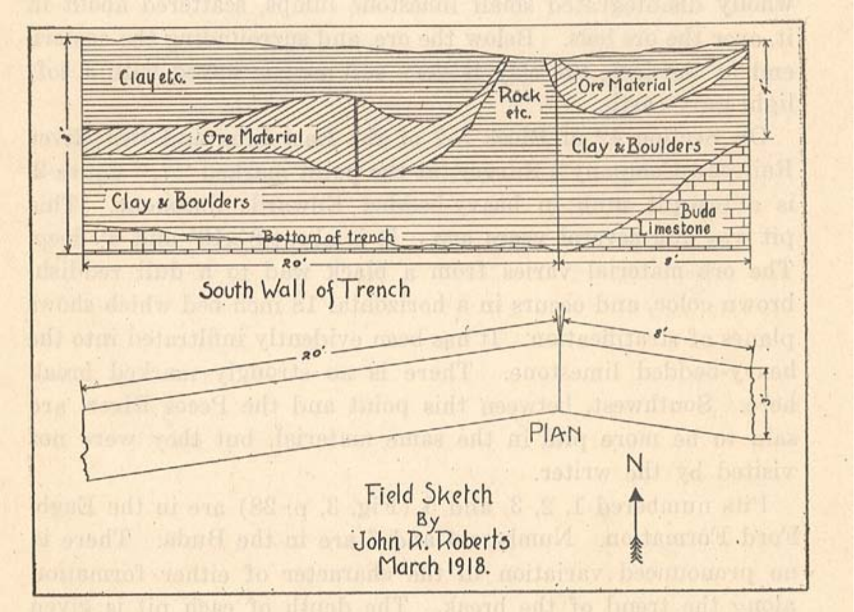


Figure 7. Field sketch of trench at point 4, figure 2.

from any lumps. The boulders are large, some of them being two feet in diameter. The limestone in these boulders is mostly a compact cream-colored rock, without a trace of bedding; nor was any fossil observed. This is mostly the Buda limestone.

On Section 64 of Block S-2, of the East Line and Red River Railroad Company's Survey, 400 feet northeast of point marked "6," figure 2, on the same break, is a large pit or glory-hole. Below is given a sketch of the workings, made at the time of the writer's visit.

The ore material appears to be hard, more compact, and less porous than wad usually is, and to be a replacement of the limestone. This exploration was started on one of the largest surface exposures of ore known to the local explorers. The limestone exposed in the test-pit itself is shattered, broken, and porous, and of a dirty yellow cream color. In the drift and below the ore, the limestone is less broken and porous, and on a fresh surface is cream white, and without evidence of stratification. No fossils were noted. This is the Buda limestone. The clay is dark yellow and wax-like, and contains a few not wholly disintegrated small limestone lumps, scattered about in it, over the ore lens. Below the ore, and surrounding the eastern end of the lens, the clay is very soft and is mixed with a soft light gray earth.

On Section 42 of Block S-2 of the East Line and Red River Railroad Company's Survey, at the point marked "7," figure 2, is a test-pit sunk in heavy-bedded Edwards limestone. This pit was dug several years ago. It is about 8′x10′ and 6′ deep. The ore material varies from a black wad to a dull reddish-brown color, and occurs in a horizontal 18 inch bed which shows planes of stratification. It has been evidently infiltrated into the heavy-bedded limestone. There is no strongly marked break here. Southwest, between this point and the Pecos River, are said to be more pits in the same material, but they were not visited by the writer.

Pits numbered 1, 2, 3, and 5 (Fig. 3, p. 28) are in the Eagle Ford Formation. Numbers 4 and 6 are in the Buda. There is no pronounced variation in the character of either formation along the trend of the break. The depth of each pit is given

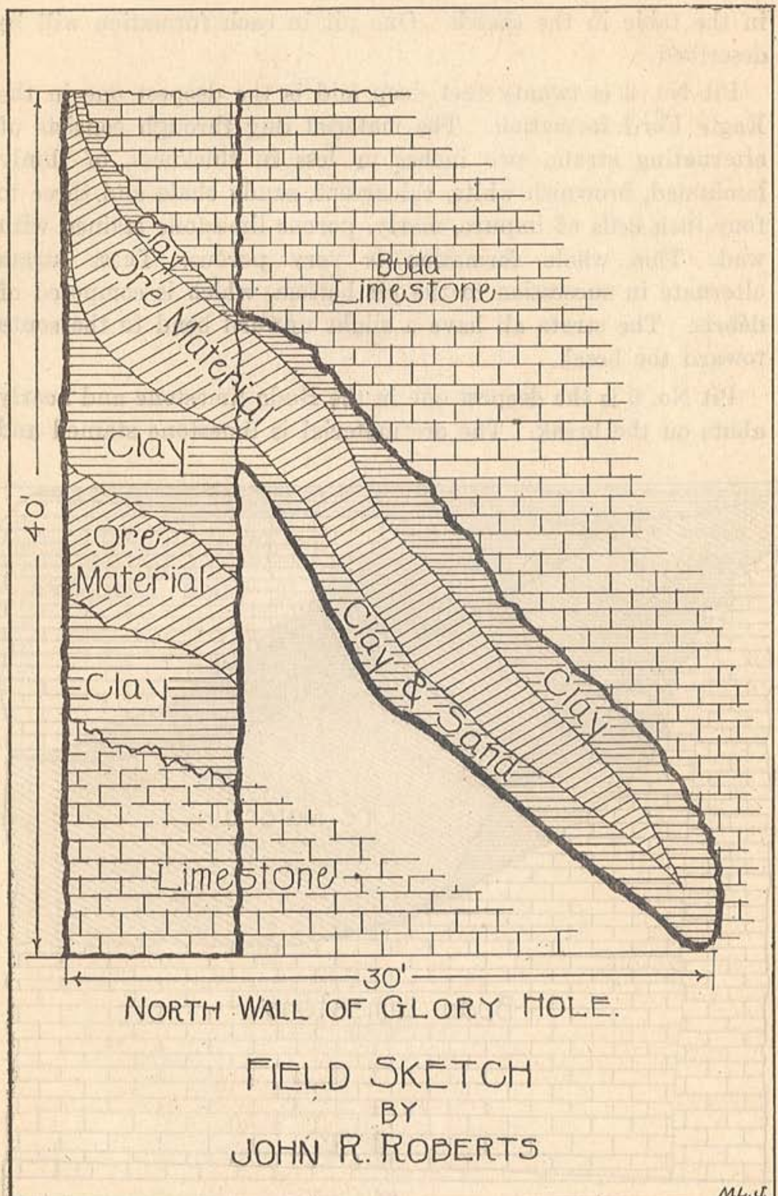


Figure 8. Field sketch of the glory-hole at point 6, figure 2.

in the table in the sketch. One pit in each formation will be described.

Pit No. 2 is twenty feet deep and is the deepest one in the Eagle Ford formation. The material dug through consists of alternating strata, two inches or less in thickness, of thinly laminated, brownish white, calcareous, sandy shale and three to four inch beds of impure, marly, porous limestone stained with wad. This whole formation is very porous. These strata alternate in succession to the pit bottom, which is composed of débris. The strata all have a slight upward bend to the south toward the break.

Pit No. 6 is the deepest one in the Buda limestone and nearly abuts on the break. The ore material is limestone stained and

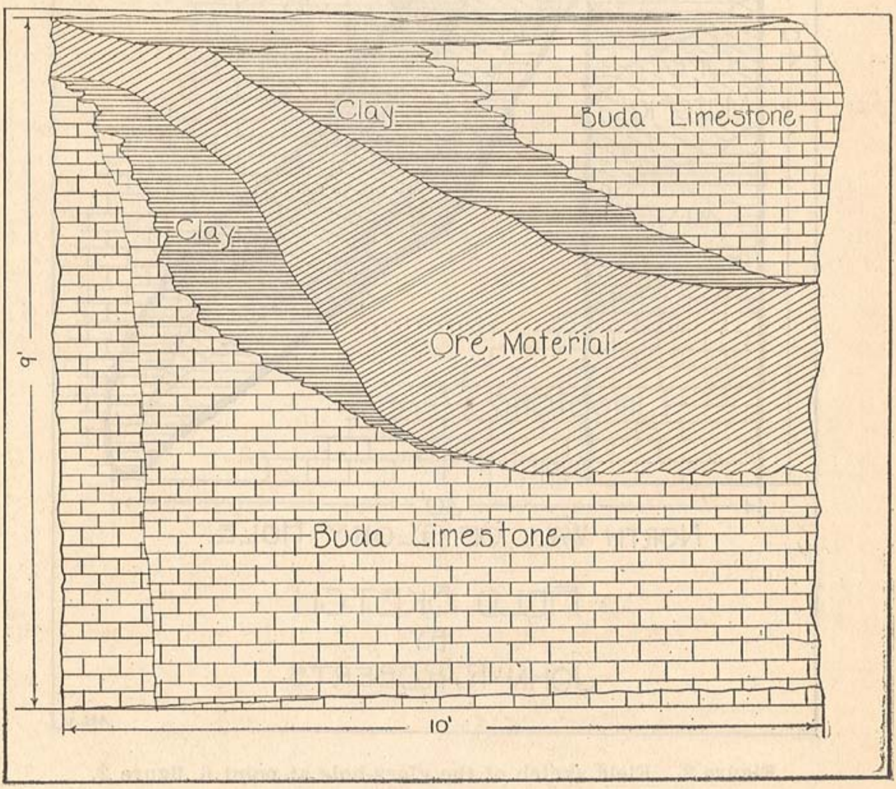


Figure 9. Field sketch of east wall of Pit No. 6, figure 3.

mixed with wad, and it outcropped at the surface. It occurs as a lense dipping from the contact of the Eagle Ford and Buda southward at an angle of 40° into the limestone. The limestone is hard, compact, bluish-white in color, and without a trace of fossils or bedding. The pit has been dug to a depth of 9 feet. Yellow, wax-like clay occurs between the limestone and the ore material, both above and below. No boulders were noted. The sketch given above, figure 9, shows that the ore material might be found for some distance in the limestone as a replacement of some of its more porous strata.

### *Water Level*

It will have been noted from the descriptions and sketches given that all of the breaks are free from water. The ore material has not, so far is known to the writer, been found in any stratum which now carries water.

### *Analyses of Ore Materials*

Quantitative analyses of the principal constituents of thirteen samples were made and are given below. The samples taken are not picked specimens of the ore materials selected with the intention of getting the best grades. They were taken by the writer *with the view of obtaining average samples,* and each one consisted of approximately four pounds of material, which was quartered down by the analyst. A brief description of where the samples came from and how they were taken is given following the table of analyses. Analyses of the manganese ores submitted to the Chemistry Division of the Bureau show the contents of manganese oxide, iron oxide, alumina, silica, phosphorus pentoxide, lime, magnesia, moisture, and loss on ignition to be as follows:

TABLE OF ANALYSES.

J. E. STULLKEN, ANALYST

| No. | Silica | Iron oxide | Alumina | Phosph. pentox. | Mang. oxide | Lime | Magnesia | Water | Loss on ignition |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 59.70 | 7.39 | 4.06 | 0.25 | 4.93 | 11.37 | 0.72 | 0.44 | 7.96 |
| 2 | 10.66 | 8.86 | 8.92 | 0.32 | 4.74 | 31.07 | 0.95 | 1.42 | 18.20 |
| 3a | 1.90 | 9.60 | 10.73 | 0.27 | 5.54 | 35.42 | 0.80 | 0.90 | 23.70 |
| 3b | 74.90 | 17.50 | None | 0.32 | None | 2.58 | 0.65 | 0.84 | 2.80 |
| 4 | 9.06 | 19.20 | 17.01 | 0.29 | 13.37 | 19.65 | 0.60 | 2.41 | 13.50 |
| 5 | 31.60 | 20.68 | 13.41 | 0.61 | 3.26 | 10.59 | 1.16 | 4.20 | 11.90 |
| 6 | 11.78 | 11.81 | 7.49 | None | 8.09 | 31.02 | 3.62 | 1.48 | 16.56 |
| 7 | 14.90 | 3.70 | 16.48 | 0.48 | 3.52 | 17.16 | 1.20 | 4.90 | 21.90 |
| 8 | 17.30 | 4.42 | 4.23 | 0.25 | 2.57 | 34.43 | 1.23 | 2.60 | 23.60 |
| 9 | 18.16 | 10.34 | 1.81 | 0.25 | 4.59 | 37.07 | 0.91 | 2.24 | 28.20 |
| 10 | 15.16 | 10.34 | 15.23 | 0.23 | 5.86 | 25.59 | 0.91 | 0.91 | 24.26 |
| 11 | 13.87 | 3.47 | 6.70 | None | 6.20 | 33.97 | None | 0.76 | 27.10 |
| 12 | 9.66 | 5.91 | 3.08 | 0.19 | 3.16 | 39.14 | 0.80 | 1.30 | 31.50 |

## *List of Samples*

No. 1. Taken from ore material in place in Pit No. 6, shown on figure 3. The heavy line on Figure 9 indicates where the sample was taken from top to bottom.

No. 2. Taken from ore material in place in Pit No. 2, shown on figure 3. This sample consists of material from top to bottom of the east wall of pit.

No. 3a. Taken from ore material in place in the 18 inch thick, black bed in the pit at point 7, figure 2. This sample was broken off the solid ledge.

No. 3b. Taken from the brown-colored strata in the pit at point 7, figure 2. This sample was broken off the solid ledge.

No. 4. Taken from the dump at point 7, figure 2. This is a composite sample of the material as sorted out by the prospectors.

No. 5. Taken from across the exposed face of the lense marked No. 1, in figure 4. Heavy line indicates where sample was taken.

No. 6. Taken from across the exposed face of the lense marked No 2 in figure 5. Heavy line indicates where sample was taken.

No. 7. A composite sample of ore material in the exposed face of lenses, 1, 2, and 3 in east wall of the trench shown in figure 4, located at point 1, figure 2. Heavy line indicates where sample was taken.

No. 8. Taken from top to bottom of the exposed face of ore material in place in the trench shown in figure 7. The heavy line in the figure indicates where sampling was done.

No. 9. Ore in place in trench, Survey 63, Block S-2 East Line and Red River Railroad Co.

No. 10. Taken from dump at glory-hole at point No. 6, figure 2. This is a composite sample of ore material which had been sorted out by the prospectors.

No. 11. Taken from Scherer & Whall's shipping platform at Shumla. It is a composite sample of the material found there.

No. 12. Taken from the dump at the trench shown in figure 6. This is a composite sample of the ore material as sorted out by the prospectors.

*Genesis of Ore Material*

Little is known of the age of the manganese-bearing deposits. Wad and pyrolusite are the two manganese minerals of the small bodies of ore material of the Shumla District. These two minerals are oxides of secondary origin. Hence, it follows as a self-evident fact that the deposits are the result of leaching and secondary concentration by meteoric waters, even though they are now dehydrated. Water has had an excellent opportunity to circulate in the dip and strike joints and in the porous strata of the Comanchean formations. The belief that these are cavernous deposits is borne out by the accumulation of sand, clay, vegetable matter, and boulders, surrounding and intermixed with lenses of ore material. The lenses also contain stringers of clay; lime, and vegetable matter and seams of ore material are contained within the clays.

Iron in greater or less quantities is found in most rocks, and manganese is frequently associated with it. Concretions of iron and manganese are found abundantly in the upper, thin, shaly strata of the Eagle Ford formation. It is also known that other divisions of the Upper Cretaceous contain much iron oxide and probably the oxide of manganese also. Therefore, it is probable that the manganese ore materials of the Shumla District had their original source in the Upper Cretaceous formations that formerly overlay the Comanchean, but which have been eroded away.

The development of caves along joints and in the porous strata of the Comanchean limestone has been in the past, and is now, a normal process in the underground erosion of that formation. To some extent this type of erosion is now active at the present surface. The numerous caves in the walls of the many canyons leading to the three rivers of the county are in fact the result of such solution. The belief is held that the mangenese-bearing deposits were formed at a time when the rocks in the present surface were deeply buried beneath the younger rocks, but that meteoric waters were abundant and circulated freely in the dip and strike joints and in the porous strata of the Comanchean formations.

Some of the deposits have accumulated in sinks in the Buda limestone. What is known as the "race-track" just north of Scherer & Whall's mine shack, at Shumla, across the Southern Pacific Railroad, is typical. Plate 2 *a* shows clearly the contact between the Buda beneath and the overlying deposit of stratified ore material. Leading from these sinks will probably be found former water channels that are now filled or choked by material such as has been described from exposures in the pits already made.

### *Tonnages*

The irregularity of the lenses in the mixtures of ore material, clay, and boulders, tends to make it difficult to determine the tonnage of ore material that is available by selective mining, in the whole Shumla District. The writer is of the opinion that perhaps ten thousand (10,000) tons of ore material can be produced from the known occurrences in the district. There is reason to believe from the nature of occurrence of these deposits that systematic prospecting will be rewarded with the finding of more mineralized breaks.

*Mining*

Under the direction of an experienced, practical miner, a few miners can selectively mine what ore material there is now in sight in the whole Shumla District. They will not need much more than picks, shovels, a hand-windlass, hand-drills, hammers and powder to work with. Timber will not be needed, except rarely, to hold up the clays.

Not enough tonnage of manganese ore material has been shown up to warrant a very large capital investment in mining equipment. Mining costs per ton in this district would be widely variable, but they ought not to exceed $2.00 per ton. That is, the ore material ought to be brought to the surface and loaded on motor trucks or wagons at an average cost not greater than the figure given. In the immediate vicinity of Shumla, the deposits are so situated that some of them are less than one half mile from the railroad station. See figure 2. Others are all of three miles, though the roads reaching them are circuitous. Hence, it is not feasible to calculate on the cost of haulage from pit to station, but there is no doubt that one motor truck could be used more advantageously than horse or mule drawn wagons. The average haul from the pits west of Feely to that station is about two miles. See figure 3.

It is believed that all of the ore material, if it proves to have a market value, could be mined and put aboard frieght cars either at Shumla or Feely, for less than $3.50 per ton, under proper management. This figure does not include any royalty charges that might have to be paid the state of Texas, or to individuals or corporate fee or lease owners. Nor does it include amortization of capital investment.

*Markets*

There has been an insistent demand by steelmakers for manganese ores. The standard in the market for these ores is 48 per cent. manganese content per long ton (2240 lbs.). The price is based on the unit of 1 per cent. manganese content. Thus, for illustration, at a market price of one dollar and twenty cents ($1.20) a unit, 48 per cent. ore is worth $57.60 per ton, less freight and other charges. For impurities, such as an excess of phosphorus, silica, sulphur, or lime, or for a lower manganese content, the unit price is assessed a penalty. These penalties are largely an individual matter between buyers and sellers. For a high grade and pure ore, free from deleterious elements, a premium in excess of the market is paid. Thus, a 60 per cent manganese ore would have a value of $1.20x60, or $72.00 per ton, plus the agreed premium between buyer and seller, less freight and other charges.

The Shumla District has the advantage of having the Southern Pacific Railroad running through it. Hence, transportation is simply a matter of hauling the ore material four miles or less to market. Manganese buyers will purchase the ore material f. o. b. Shumla or Feely, if they want it.

## PETROLEUM

The bituminous shales of the Eagle Ford formations do contain oil, but the formation is so lacking in porosity that one would hardly expect to find accumulations of petroleum within it in Val Verde County. Beneath the Comanchean formations, which probably have a depth in this county of not less than 750 or more than 1500 feet, oil might be found in the underlying Pennsylvanian series.

Careful stratigraphic study by competent geologists might reveal indications in the lay of the Comanchean of the presence of structures in the Pennsylvanian rocks underlying the Comanchean, which might be favorable to the accumulation of oil. It is more likely, however, that if such structures are found, it will be the result of the correlation of the stratigraphy and information gained from deep boring for oil in the underlying rocks themselves, in this and adjoining counties.

## BUILDING MATERIALS

The Buda limestone is a good building stone, which can be quarried with comparative ease at many places in Val Verde County. Its great content of calcium carbonate also makes this rock available for use in making Portland Cement. The commercial value of this rock for cement-making is dependent upon suitable clays with sufficient alumina content, and the proximity of the two to each other, to cheap fuel, and to market, and sufficient supply of labor. The Del Rio clay is perhaps just the thing to mix with the crushed Buda limestone in making cement, but even so, there are no large cement markets close at hand.

The other horizons of the Comanchean formations do not appear to have any rock that is at all comparable to the Buda for building purposes. The latter is pre-eminently the best building stone in either the Comanchean or the Eagle Ford formations within the county.

The flaggy limestone strata of the Eagle Ford formation are fair building stones when not too thin, porous or badly weathered.

## WATER RESOURCES OF VAL VERDE COUNTY

By James P. Nash

Probably the most important mineral resource in Val Verde County is artesian water. The low average rainfall, combined with a high temperature and quick run off, makes an underground supply of good water of great value, not only as a life necessity for man and beast, but as a source of moisture for the production of farm products.

Due to absence of reliable data on the existing wells, it is impossible to determine a water table. It is reasonably certain however, that the water-bearing strata are in the Edwards limestone and are widely distributed over the county. It is a question as to how deep one must drill to intercept this water. The depth of most existing wells are recorded on the county map accompanying these papers and from these an estimate can be made for any nearby locality, as to depth at which water may be expected. The comparative elevation of the land on which the well is to be sunk must be considered as well as the fact that the water-bearing strata do not always lie on a horizontal plane, but may dip in any direction or even feather out and disappear.

The numerous springs that exist in this county, originate in the same strata of the Edwards limestone. The most prominent of these springs are the Pecan Springs, which supply the main water for dry season flow of the Devil's River. Many additions of water by other springs, all from the same strata of water-bearing rock, help to swell the volume of this river as it flows south. Many projects have been advanced for the utilization of this water for power and irrigation purposes, and it is believed that the execution of some of these proposed projects would do more for the advancement of the county and that part of the state than any other enterprise. The San Felipe Springs one mile north of Del Rio flow abundant water. A dam about fifteen feet in height impounds this water, and that which is not used by the city for its water supply, is diverted to irrigate the lands below the city and along the Rio Grande

River. These lands belong to the Val Verde Irrigation Company.

Good-enough Springs, south of Comstock and about one and one half miles from the Rio Grande, should be of considerable value for irrigating a small tract of land. It is a question whether a high dam could be constructed to impound this water, as the increased head might decrease the flow or cause it to cease altogether. There is however, a possibility of a successful installation of a low head turbine and of pumping the water with the power developed, or perhaps by a hydraulic ram.

Another spring is located near the high bridge over the Pecos River, but the walls of the canyon are too high to permit this being used for irrigation.

# ROAD MATERIALS OF VAL VERDE COUNTY

By James P. Nash

In the last few years the necessity of good roads has become keenly felt almost everywhere in the United States. In the ranch country of West Texas where distances are great, the advantages of quick transportation on good roads are even more than elsewhere apparent. In Val Verde County there are few ranch houses that are without a motor vehicle of some description, in spite of the fact that the roads are adverse to this type of traffic. The present roads are the outgrowth of original trails and have not been laid out with much regard for any system of alignment or grading, consequently, they are for the most part rough, and in some cases longer than necessary. The character of the country, however, does not permit long straight roads, due to the fact that it is broken up into steep canyons with intervening divides, necessitating that the roads follow the canyons or divides. The roads in Val Verde County are poor. It is a fact, however, that all the roads marked on the map have been traveled in a Ford car, but in some instances this was a rather precarious undertaking. In general, the roads run north and south, with but one road running from east to west. Three main roads run from the Southern Pacific Railroad to the northern boundary of the county. The one farther west leads from Langtry north to the Pecos River, crossing this stream at the Howards Draw, then on to Pandale, and from there north and east through the Fielder Draw to the Ozona Road. A branch from the former road leads northwest, at the Babb ranch house eighteen miles north of Langtry, to the extreme northwest corner of the county. The Ozona Road, known as the Divide Road, from the fact that it follows the top of the divide of the Pecos and Devil's rivers, runs straight north from Comstock to the county line and thence to Ozona in Crockett County. The third road is what is known as the Devil's River Road, which follows the bed of that river the greater part of the distance north to Juno, and then on to

Ozona. This is a post road bringing mail from Comstock to Juno three times a week at the present time. Another road, east of the Devil's River from Del Rio, leads northeast, but wanders into Edwards County before it touches the north county line. The road running east and west follows very closely the Southern Pacific Railroad, but there is no bridge or ford to carry this road across the Pecos River. Automobiles have often crossed this river on the Southern Pacific Railroad's high bridge, but under war conditions, this is not permitted. It is necessary in going from Comstock to Langtry to make a detour of about one hundred miles by way of the Howard crossing, mentioned before. This is a discouraging proposition. It is absolutely necessary that a highway bridge be constructed across the Pecos River to connect this road, if it is to be considered as a part of a trans-continental highway, as seems to be the intention of some organizations.

While it is out of the question at this time to consider possibilities of a first class system of highways for Val Verde County, due to the present sparse population, there could be great improvements made on the existing roads at comparatively little expense. The main reason for this is the prevalence of much satisfactory road material for lightly traveled roads. For instance, the Divide Road is laid out a good part of the distance in this county, on what is known as the Eagle Ford formation, which, when weathered, packs down into a compact, smooth surface. The chief requirement for a road of this type is that it be properly drained, so that the water will flow from the surface of the road without gouging channels in the surface. From its location on the divide good drainage is comparatively easily accomplished. Where this road branches west toward Howards crossing near Pandale, as it comes down into the canyon, it would be necessary that it be given more attention as the water flows down the steep inclines with great velocity. A good drainage system would do much to counteract this influence. It is believed, however, that this road should be kept out of the canyons as much as possible, in which event its maintenance would be much easier.

In general, it may be said, that satisfactory roads can be cheaply constructed on the divides where the surface rock is the Eagle Ford limestone. This formation is shown on the map. Where the road crosses the Buda limestone, underlying the Eagle Ford, the roads are very rough, with angular and rounded boulders protruding from the road surface. Beside these boulders, there are generally many loose, hard rocks on the surface. Steep grades are usually encountered on this rock formation. To properly construct and maintain roads on this kind of rock is a rather costly matter. By realigning the roads so that the grades will be gradual and will have a good system of drainage, these roads could be maintained in a satisfactory condition with small additional cost. The greatest expense would be that of getting the road into proper condition. In the canyons, the roads are, as a general rule, in fair condition, as they traverse the residual soil overlying the harder rock, known to geologists as the Devil's River limestone. Little need be done to these roads, as they are satisfactory under the present traffic conditions and, when they become rutted so that they are uncomfortable for travel, a new road can be located with litle inconvenience. The roads which traverse the Del Rio clay are generally badly rutted and difficult to travel. No attempt has been made to maintain them and consequently they are usually depressed and rutted, being in excellent condition to serve as a drain for the water from the surrounding fields. With proper drainage structures and some maintenance, these roads could be kept in fair condition. Where the traffic is heavy, it would be necessary to put a wearing surface of crushed stone or gravel to take up the wear. The Divide Road and the Devil's River Road, for a number of miles north of Comstock, illustrate these conditions and the necessity of some system of maintenance.

The possibilities of the main road from Eagle Pass through Del Rio west to the county line, not only as a trans-continental highway, but as a military highway, should not be overlooked. At the present time, it would be practically impossible to move troops from the eastern part of the county to the west on the highways. In the first place, it would be necessary to construct a highway bridge over the Pecos River, as the present railroad bridge is inadequate for this purpose. This is expensive, but would be necessary for the movement of troops and their equipment by transport. Furthermore, the present road is so rough in many places as to be of little use in the transportation of heavy trucks and artillery. It might be possible to use the old Southern Pacific right-of-way to cross the river, but this has a number of disadvantages. It offers a fine target for troops on the other side of the Rio Grande. Furthermore, there are a number of fills too narrow for a military highway, which would necessarily have to be widened and protected by fences.

Val Verde County was found to be well supplied with road materials satisfactory for the traffic needs of the county. The nature of the country precludes the possibility of any large agricultural development, except along the Devil's River. With few exceptions, it is safe to say that most of the roads of the future in this county will be lightly traveled. This being the case, the roads can be surfaced with the natural materials. As suggested before, on the divides where the surface material is the Eagle Ford formation, little other material is necessary. This compacts into a hard crust and resists wear to a considerable extent. In many of the draws good gravel can be found for the surfacing of the roads in the vicinity. This gravel is, as a general rule, satisfactory as a concrete aggregate so that a ready material is available for the construction of concrete fords or bridges, should the latter be considered necessary.

Along the Devil's River Road, where the heaviest traffic to the north exists, materials are close at hand. Gravel is found along the bed and banks of this river and is very satisfactory for road construction. The tests on several of these gravels are included in this report. The surrounding rock is the Comanchean limestone, which the accompanying analysis shows to be equal to any limestone in the state for road construction. The sample is representative of the Comanchean limestone shown on the geological map.

The one heavy traffic road in the county is the Del Rio-Comstock Road, which will undoubtedly have to be surfaced with a road metal in the near future. Local materials can be used, for the most part, for this purpose. The presence of the railroad will permit the importation of materials, where the local materials are not found satisfactory.

The following are the results of tests made on representative materials found in this county:

MECHANICAL ANALYSIS

| | No. 3543 | No. 3544 | No. 3545 |
|---|---|---|---|
| Material retained on the 2" sieve | 9.8 | 8.8 | 6.6 |
| Material retained on the 1" sieve | 27.6 | 33.9 | 19.9 |
| Material retained on the ½" sieve | 42.1 | 58.8 | 48.7 |
| Material retained on the ⅛" sieve | 67.3 | 78.5 | 68.8 |
| Material retained on the .1033" sieve | 83.0 | 83.3 | 70.0 |
| Material retained on the .0116" sieve | 88.2 | 89.1 | 74.2 |
| Material retained on the .0058" sieve | 89.2 | 90.8 | 77.0 |
| Material retained on the .0029" sieve | 89.7 | 91.9 | 78.4 |
| Material passing the .0029" sieve | 9.7 | 7.3 | 21.4 |
| Total | 99.4 | 99.2 | 99.8 |
| Cementing value on | | | |
| Material over ⅛" in size | | | |
| Material under ⅛" in size | Poor | Poor | Fair |
| Material as received | Fair | Good | Excellent |

No. 3543. This sample of gravel was found ten miles south of Juno, Val Verde County, along the bank of Devil's River, where Devil's River Road crossed the river. This is a well graded gravel, composed of rounded pebbles of a hard limestone with sufficient clay to supply the necessary binder. This material is very satisfactory for road construction. Roads having considerable automobile traffic, should, however, have a bituminous topping.

No. 3544. This sample of gravel was found in the bed of Devil's River at the crossing of the Del Rio-Comstock Road, Val Verde County. This is a well graded gravel composed of rounded pebbles of limestone and some flints. It should make a satisfactory road material. Stones over two inches in size should be removed from gravel when road is being constructed.

No. 3545. This gravel was found on the bank of Sycamore Creek, twelve miles southeast of Del Rio at the crossing of the Del Rio-Eagle Pass Road. This is a well graded gravel composed of rounded pebbles of a hard limestone and a small amount of chert with considerable good binder. It should make a very good road material, but stones over one and one-half inches or two inches in size, should be removed before the gravel is compacted in the road.

TEST OF COMANCHEAN LIMESTONE (LAB. NO. 3546)

| Sp. Gr. | Wt. per cu. ft. | Water abs. lbs. per cu. ft. | Per cent of wear | French coef. of wear | Hardness | Toughness | Cementing value | Compression lbs. per sq.in. |
|---|---|---|---|---|---|---|---|---|
| 2.66 | 166 | 1.49 | 3.8 | 10.4 | 13.5 | 7 | (14) Fair | 15,500 |

No. 3546. This sample of limestone was found on the road from Del Rio to Sonora, about ten miles north of Del Rio, Val Verde County. This limestone is rather soft with low toughness but medium resistance to wear, fair cementing value, and medium resistance to compression. It is about an average of the better types of limestone in use for road construction in Texas. It should be satisfactory for medium traffic roads, or in a concrete road under fairly heavy traffic.

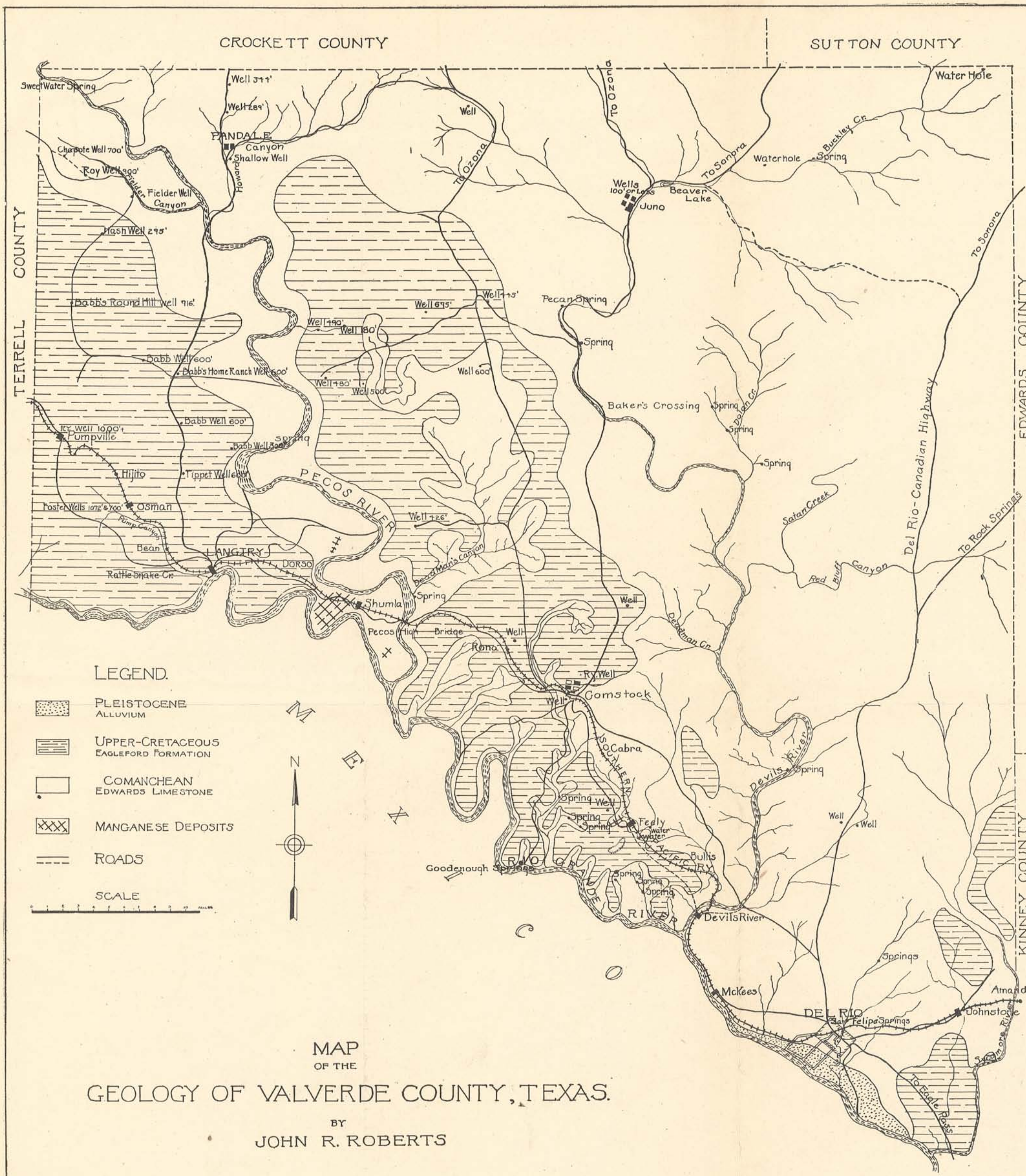


Plate 1. Sketch map of the geology of Val Verde County.

Plate 2*a*. Photograph of the disconformable contact between the Buda and Eagle Ford formations, that is, the Upper Cretaceous and Comanchean, as seen in a cut of the Southern Pacific Railroad, about four miles west of Shumla. Photograph by Beede.

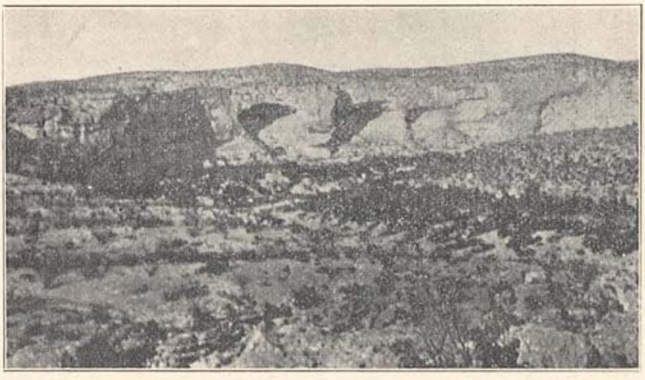

Plate 2*b*. Topography and caves in Comanchean limestones about one mile southeast of Langtry. The caves shown are on the Texas side, on the north wall of the Rio Grande River canyon. Photograph by Beede.

Plate 3*a*. View of Bird's Nest Canyon, looking southwest, one mile east of Langtry. In the foreground are seen the effects of weathering on the dip and strike joints and the porous strata within the Comeachean limestones The re-entrant angles along the canyon walls are typical of all the canyons in Val Verde though more pronounced than usual. Photograph by Beede.

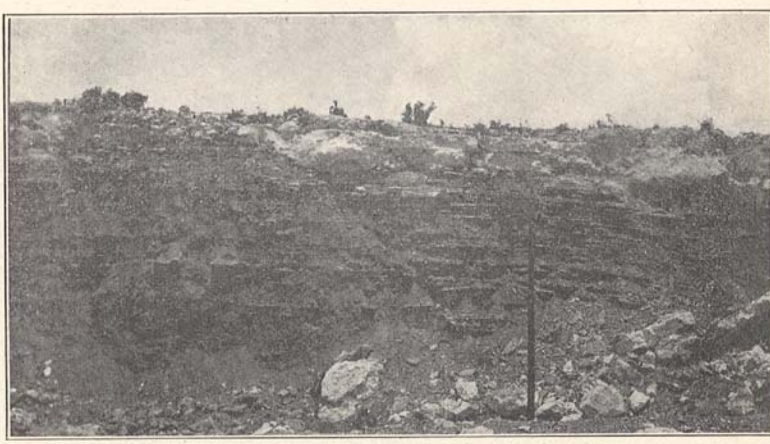

Plate 3*b*. An exposure of Del Rio clay capped by a remnant of Buda limestone in a cut on the Southern Pacific Railroad, a quarter of a mile west of the station at Comstock. Photograph by Beede.

Plate 4. Photograph, looking toward the east, of a trench dug in ore material in a break in the Buda limestone, at point 5, figure 2. Photograph by Becde.

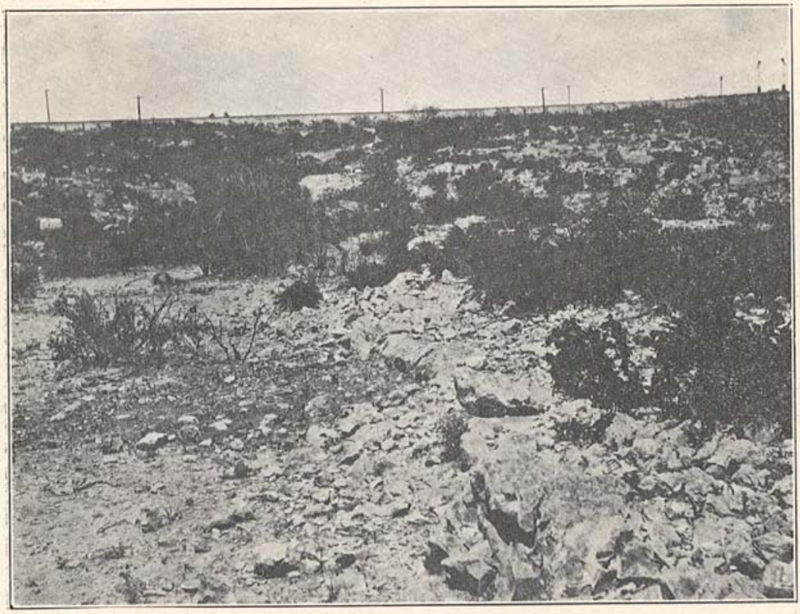

Plate 5*a*. Photograph looking northeast along the strike of a break which is about a half mile west of Shumla. The Southern Pacific Railroad is shown in the distance. The railroad crosses the break. Photograph by Beede.

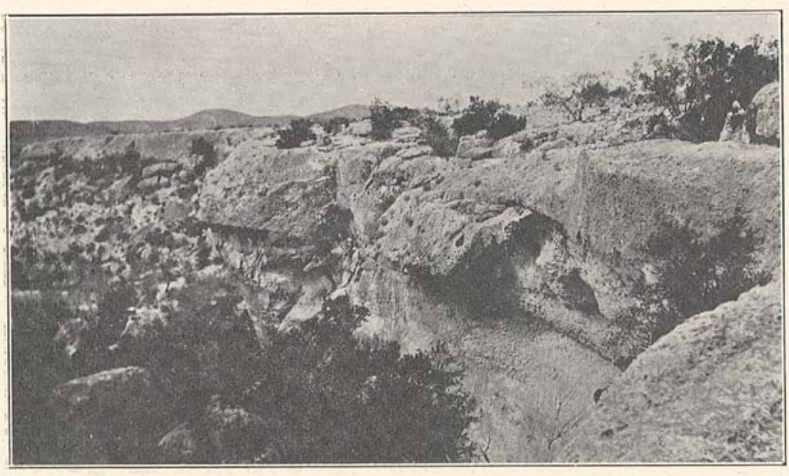

Plate 5*b*. Photograph, looking south and west along Bird's Nest canyon, one mile east of Langtry. The horizontal solution channel in the Edwards limestone about fifteen feet below the surface is shown clearly in the middle foreground. Photograph by Beede.